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Phytochemical studies of *Gardenia jasminoides* – A Review

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Abstract
Gardenia jasminoides Ellis belongs to family *Rubaiceae*, a traditional Chinese herbal medicine, also known as cape jasmine or cape jessamine. All parts of the plant possess a multitude of phytochemical secondary metabolites which impart an unprecedented variety of medicinal uses to the plant. It is interesting to note that a single plant species finds use for treatment of a wide spectrum of health disorders in traditional and folk medicine. From the point of view of phytochemistry, give scope for enhancement of the quality and quantity of the bioactive secondary metabolites occurring in the plant. In the present review, efforts have been made to mingle up different aspects of scientific studies related to secondary metabolites on this medicinal plant. Scientific evidences are available on various medicinal aspects i.e. anti-diabetic , anti-inflammatory, detoxifying , anti-oxidative anti-angiogenic properties *etc*. to name a few.

Keywords: Phytochemical, secondary metabolites, *Gardenia jasminoides*, Geniposide, Genepin

INTRODUCTION

G.jasminoides Ellis belongs to family *Rubaiceae*. It is an ornamental woody plant. It has white flowers with sweet fragrance [1]. It use as a cut flower and a garden shrub. It is a popular pot plant in the US and many European countries [2]. The leaves and fruits possess antibacterial, demulcent and diuretic properties. They are used in treating fever, jaundice, sore throat, bloody stools and dysuria [3]. It is also interesting that the major colorant, crocin, has long been used as a food additive and may act as an antioxidant [4]. The crude extract of *G.jasminoides* had been also used for pharmaceutical purpose such as choleretic action for liver disease control and relief of type 2 diabetic symptoms [5] and is capable of inhibiting various types of cancer cells and human fibrosarcomol cells [6].

The *G.jasminoides* species is the most common of these fragile plants and material from dried Gardenia flower petals is commonly used in Chinese herbal medicine. Its Chinese name is zhi zi. The traditional medicinal actions attributed to gardenia include calming irritability; cooling blood and clearing away heat (a yin/yang imbalance often characterized by deficient yin); reducing swelling; and moving stagnant blood that has congealed in one place, usually following trauma.

Gardenia is considered to be very effective as a hemostatic agent, which means that it stops bleeding; and also effective in treating injuries to the muscles, joints, and tendons. Gardenia is commonly used in Chinese herbal formulas to treat infections, particularly bladder infections; abscesses; jaundice; and blood in the urine, sputum, or stool. Because of its perceived ability to ease agitation or irritability, it is also used in formulas to treat anxiety or insomnia. It is also helpful in correcting menopausal imbalances reflected in insomnia and depression, nervous tension, headache, and dizziness.

It is important to remember that Chinese herbal medicine is based upon individual prescriptions developed for each patient and their unique symptoms. Chinese herbs should not be taken, either individually or in formulas, unless a practitioner of Chinese herbal medicine is first consulted.

Medicinal properties

G.jasminoides, also known as cape jasmine or cape jessamine, is a common type of gardenia that has a long history of medicinal use. Not only has *G.jasminoides* been used in Chinese medicine for hundreds of years, but extracts of the gardenia fruit have been scientifically studied and proved to be effective for many of the same conditions for which Chinese medical practitioners have been prescribing it for centuries. *Zhizi*, as *G.jasminoides* is called in Chinese medicine, is considered a bitter, cold herb that helps with yin deficiency. In conventional Western medicine, the medicinal plant has been shown effective in reducing inflammation and exhibits anti-angiogenic properties.

The United States Department of Agriculture Agricultural Research Service phytochemical and ethnobotanical database lists *G.jasminoides* as having specific medicinal properties. This gardenia has been found to be helpful in the treatment of pain, nose bleeds, fever, and influenza; in healing wounds and reducing swelling; and in treating mastitis, hepatitis and the hematuria that accompanies bladder infection. *G.jasminoides* has been found to be helpful in the treatment of pain, nose bleeds, fever, and influenza; in healing wounds and reducing swelling; and in treating mastitis, hepatitis and the hematuria that accompanies bladder infection.

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G.jasminoides (Chinese name "Zhi Zi"), *Rubiaceae*, a traditional Chinese herbal medicine, has been widely recognized in many Asian countries as a diuretic, a laxative, and a choleretic, as well as a cure for hepatic pains due to cirrhosis and for abdominal pains due to dysentery [7]. It has also been used as an analgesic, an antipyretic [8], and an anti-inflammatory medicine [9].

In traditional Chinese medicine, the kernel of the *Gardenia jasminoides* berry is made into a paste and used to treat redness and swelling for conditions like rheumatoid arthritis. It is considered effective for relieving anxiety and agitation, so it is frequently prescribed for depression and insomnia. Some aromatherapists prescribe gardenia oil for anxiety and nervous tension owing to its calming effect.

G.jasminoides may also be used to treat physical and emotional menopausal symptoms. Traditional Chinese medicine practitioners use it to cool and detoxify the blood, stop bleeding, and help injuries to heal more quickly. Due to this ability, it is used to treat nosebleeds and other bleeding conditions, such as blood in the urine.

Gardenia fruit is an important part of Chinese herbal medicine. It is considered to be antiphlogistic (anti-inflammatory), analgesic, diaphoretic, sedative, and hemostatic, and is prescribed for depression, fever, liver disorders, anxiety, insomnia and nervousness. In Chinese medicinal terms, it is used to purge fire, clear heat, allay irritability, cool the blood, and to detoxify. It is also used by the Chinese for inflamed eyes, tumors, painful urination and reddish-coloredurine.A popular Japanese-Chinese formula, called the Tang Kuei (Dong Quai) & Gardenia formula is used for irregular and difficult menstruation, vaginal bleeding, menopausal problems, and a variety of dermatological problems. Also in the formula are rehmannia, peony, cnidium, coptis, philodendron and scute.

PHYTOCHEMICAL STUDIES

A number of effective constituents of *G.jasminoides* Ellis have been reported, such as geniposide, gardenoside, shanzhiside, scandoside methyl ester, deacetyl-asperulosidic acid methyl ester [10], crocin [11], and polysaccharide [12]. Since many polysaccharides play an important role in cell-to-cell communication, cell adhesion, and molecular recognition in the immune system [13], some activated polysaccharides isolated from natural sources have lately attracted much attention in the field of biochemistry and pharmacology [14-17].

G.jasminoides (Rubiaceae) fruits accumulate iridoid compounds, such as geniposide and gardenoside [18], and the dried fruits have been used as a crude drug in traditional Chinese medicine. Cultured *G.jasminoides* cells have been used to investigate iridoid biosynthesis because they produce small amounts of iridoids even after dedifferentiation [19-21]. Iridoids are one of the most widely distributed secondary metabolites in higher plants. They are pharmacologically active principles in various medicinal plants, and key intermediates in biosynthesis of monoterpenoid indole alkaloids as well as quinoline alkaloids. Although most iridoids are present as 1-*O*-glucosides, the glucosylation step in its biosynthetic pathway has remained obscure.

Geniposide is one of the major iridoid glucosides in the fruit of *G.jasminoides* , which has been reported to possess anti-inflammatory activity (inhibition of 5-lipoxygenase) [22], activity against tumorpromoting12-O-tetradecanoyl-phorbol-13-acetate (activation of protein kinase C) [23,24], and which have been used for treatment of a liver disorder (inhibition of P450-3A monooxygenase) [25]. Some authors [26-28] also found that geniposide could promote collagen synthesis in false-aged rats, stimulate the proliferation of endothelial cells but, interestingly, also act as a cross-linking agent with low cytotoxicity and biocompatibility.

Geniposide is an iridoid glucoside extracted from *G. jasminoides Ellis* fruits, which have long been used in traditional Chinese medicine [29]. This compound has been shown to posses anti-diabetic [30], anti-inflammatory [31], detoxifying [32], anti-oxidative [33] and anti-angiogenic properties [34]. The first report of its hypoglycemic activity in high sugar diet-induced diabetic mice was made in 1982. Recent studies further confirmed the hypoglycemic effects of geniposide and genipin, an aglycone of the enzyme-hydrolytic geniposide [35,36]. The anti-diabetic property of genipin is related to the inhibition of uncoupling protein 2 (UCP2), a mitochondrial carrier proton geniposide. However, little is known about the biochemical mechanisms by which geniposide regulates hepatic glucose-metabolizing enzymes.

Geniposide , the main iridoid glucoside of the gardenia fruit, hasbeen suggested to show a chemopreventive effect in early acute hepatic damage induced by aflatoxin B1 [37,38] and also to possess detoxification, anti-tumour and anti-thrombotic activities [39].

Genipin can be obtained from its parent compound geniposide, which may be isolated from the fruits of *G.jasminoides* [40,41]. In herbal medicine, genipin and its related iridoid glucosides have been widely used as an antiphlogistic and cholagogue [42]. The *in vitro* cytotoxicity of genipin was previously studied by our group using 3T3 "broblasts [43].

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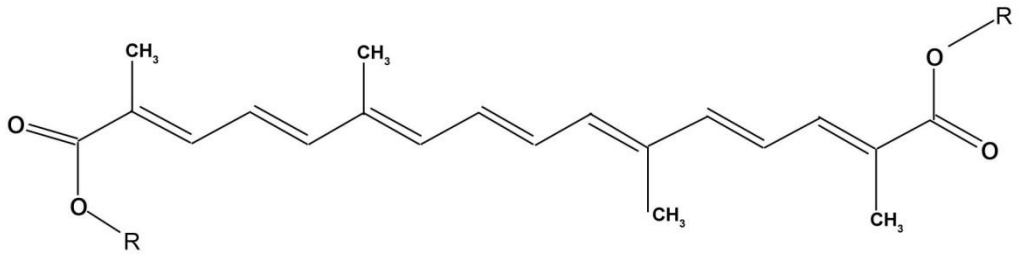
Genipin is an agent extracted from gardenia fruit (*G.jasminoides ELLIS*). In traditional Chinese medicine, genipin has been used as a treatment for DM or jaundice patients. Many studies have reported on genepin's much lower level of cytotoxicity compared to glutaraldehyde [44].

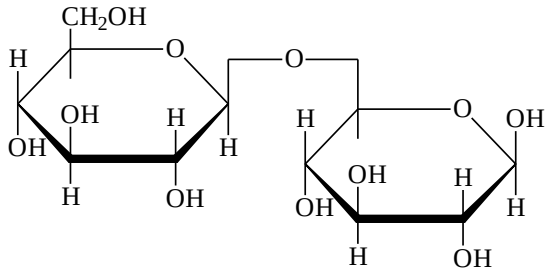
Genipin, which has a $C_{11}H_{14}O_5$ molecular structure, is iridoid glycoside, which is one of the main ingredients in gardenia fruit (*G.jasminoides ELLIS*). Genipin generates crosslinks spontaneously with protein, collagen, gelatin, chitosan, etc. For a long time, genipin has been used as a treatment for cholestasis and hepatitis in traditional Chinese medicine. It has even been used as a natural dye because of its tinting properties with proteinic textiles [45]. Genipin itself has no color, but forms blue particles by spontaneous reaction with amino acids and protein. These characteristics of genipin have allowed it to be used as a natural dye for textiles and for food. Many studies have noted the remarkably low cytotoxicity and genotoxicity of genipin compared to glutaraldehyde [46].

Gardenia jasminoides is a medicinally important plant. The fruits of this plant are considered medicinally useful in Chinese medicine. They contain yellow carotenoid pigments, crocin and crocetin [47].The structures are shown below.

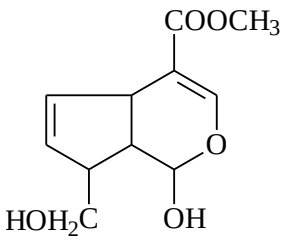


Crocin : R = Gentiobiose

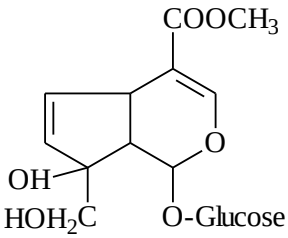
Crocetin : R = H



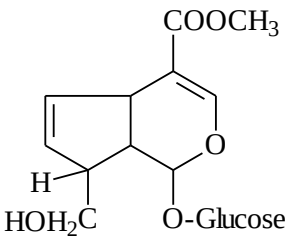
Gentiobiose



Genipin



Gardenoside



Geniposide

These yellow pigments have been used as a natural food colourant for a long time in Japan, mainly in coloured juice, jelly, candy and noodles, because of their water solubility [48].The fruits contain iridoid glycosides, Gardenoside and geniposide which are used as tranquilizers and precusor of gardenia blue pigments. The structures are shown above.

The fruits of this plant are included in Chinese traditional formulations. The folkloric use of these fruits is for the treatment of inflammation, jaundice,

headache, edema, fever, hepatic disorders and hypertension. Their pharmacological actions such as protective activity against oxidative damage, cytotoxic effect, anti-inflammatory activity and fibrinolitic activity have already been elucidated [49].

Geniposide is one of the major iridoid glycoside of the fruits. It is hydrolyzed to the aglycone genepin by B-D glycosidase in the intestines and the liver. Genepin and geneposide were found to possess a number of pharmacological actions like the anti inflammatory activity, antiasthmatic activity etc.

CONCLUSION

The plant *G.jasminoides* should be further investigated for isolation of secondary metabolite compounds. Export of raw plant drugs is being the way for generating income to our country. But same raw drugs will have a multifold of economic values after a partial or full scientific screening and validation. So, such a scientific screening is essential to understand the active principle, mode of action of that particular plant drugs as well as to generate a higher income. Further fractionation and complete evaluation of the active components of this plant will be a better approach in future.

Furthermore, the active participation of such natural custodians and practitioners of valuable knowledge is guaranteed in the generation of research focussing on screening programmes dealing with the isolation of bioactive principles and the development of new drugs.

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